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Double-crested cormorant satellite telemetry: preliminary insight

Scott J. Werner
USDA, APHIS National Wildlife Research Center, Mississippi Research Station, Scott.J.Werner@aphis.usda.gov

D. Tommy King
USDA, APHIS National Wildlife Research Center, Mississippi Research Station, tommy.king@aphis.usda.gov

David E. Wooten
USDA, ARS, H.K. Dupree National Aquaculture Research Center

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Scott J. Werner, USD A/ APHIS/ Wildlife Services/ National Wildlife Research Center, Mississippi Research Station, P.O. Drawer 6099, MS State University, MS 39762, USA

D. Tommy King, USDA/ APHIS/ Wildlife Services/ National Wildlife Research Center, Mississippi Research Station, P.O. Drawer 6099, MS State University, MS 39762, USA

David E. Wooten, USDA/ Agricultural Research Service/ H.K. Dupree National Aquaculture Research Center, P.O. Box 860, Stuttgart, AR 72160, USA

Abstract: Migratory paths of North American waterbirds have traditionally been evaluated by relocating birds banded as nestlings. Although over 8,000 banded Double-crested Cormorants *(Phalacrocorax auritus)* have been recovered in North America since 1923, the movements of wintering and breeding cormorants remain poorly understood. We initiated a satellite telemetry study to determine the annual and regional distributions of 25 cormorants (in each of two study years) captured near primary aquaculture areas in Alabama, Arkansas, Louisiana, and Mississippi. Preliminary data suggest that cormorants generally remained near aquaculture facilities where they were captured, marked, and released. Two cormorants, however, emigrated from primary aquaculture areas prior to their spring (northward) migrations. In addition to impacts to southeastern aquaculture, cormorants may also negatively impact other fisheries, including those in the Great Lakes region of the United States. Localized breeding-colony control activities were implemented in eastern Lake Ontario in 1999 to reduce these impacts. We began a second, 2-year satellite telemetry study *(n* = 25 per year) to determine cormorant emigration, reproductive success, nest-site fidelity, and site-specific foraging distribution following control activities at Little Galloo Island in western New York. Preliminary data suggest that cormorants remained near the breeding colony from May-September 2000. Two groups did, however, emigrate from Little Galloo Island in July and were observed near Montreal and Oneida Lake. When completed, these studies will collectively provide abiological basis for the management of cormorant impacts to commercial and recreational fisheries.

Keywords: aquaculture, depredation, fisheries, migration, *Phalacrocoraxauritus,* waterbird, wildlife management

Among all fish-eating birds in North America, the double-crested cormorant *(Phalacrocorax auritus)* is most often regarded as the predominant avian predator that negatively impacts commercial and recreational fisheries in the United States. These impacts are particularly noticeable in the primary aquaculture states of the southeast, where wintering populations of cormorants have nearly tripled in recent years (Glahn et al. 2000a). Glahn et al. (in press) estimated that double-crested cormorants consume over $5 million of commercially produced catfish fingerlings each year in the delta region of Mississippi. Given that these fingerlings would have been raised to larger, marketable fish valued at approximately $0.80 per pound, aquaculture producers in southeastern states may realize a $25 million profit loss each year due to cormorant depredation (Glahn et al. in press). Double-crested cormorants have also been reported to negatively impact populations of smallmouth bass and other fishes in the Great Lakes region of the United States (Schneider et al. 1999).

In cooperation with USDA/APHIS/ Wildlife Services, the U.S. Fish and Wildlife Service is presently developing an Environmental Impact Statement and a National Management Plan for the double-crested cormorant. The range of double-crested cormorants associated with fishery impacts throughout the United States remains poorly understood. Previous investigations of cormorant movements have been constrained by the limited study area associated with VHF radio telemetry and the emigration of birds from these study areas (King 1996, King et al. 1995). In supplement to flyway patterns elucidated by banding nestlings in the Great Lakes region since 1923, modern technology (e.g., satellite telemetry) enables wildlife researchers to evaluate the daily and annual movements of waterbirds over large spatial scales.

The present summary provides preliminary insight regarding the wintering and breeding distributions of double-crested cormorants captured near southeastern aquaculture facilities and at a traditional breeding colony in eastern Lake Ontario, respectively. By understanding the breeding distribution of cormorants captured near southeastern aquaculture facilities, and the foraging distribution of breeding individuals, various alternatives for managing cormorant impacts to commercial and recreational fisheries can be developed and evaluated based on subsequent analyses of these spatial data.

Methods

Satellite telemetry near southeastern aquaculture

In November 1999, we initiated a 2-year study to investigate winter movements of double-crested cormorants captured near aquaculture facilities in Alabama, Arkansas, Louisiana, and Mississippi. This research was a collaborative study between the National Wildlife Research Center and the USDA/ ARS/ H.K. Dupree National Aquaculture Research Center (Stuttgart, AR), and was conducted in cooperation with biologists from USDA's Wildlife Services programs in AL, AR, LA, and MS. The objectives of this study are to determine (1) the movements of wintering cormorants following their arrival near southeastern aquaculture facilities, and (2) the subsequent breeding distribution of cormorants captured adjacent to southeastern catfish farms.

We captured 25 double-crested cormorants from November 1999 through March 2000 (Figure 1) using a night-lighting technique developed by King et al. (1994). A backpack harness (adapted from Dunstan 1972, King et al. 2000) was used to attach satellite transmitters, or platform transmitter terminals (PTT) on all cormorants. We used a 45 g PTT (< 1.8% bird weight) manufactured by Microwave Telemetry, Inc. (Columbia, MD). The body of the transmitter measured 48x17x7 mm (1.90x0.65x0.28 inches), with a 216 mm (8.5 inch) flexible antenna protruding from the back edge of the transmitter 45 degrees from the bottom face. Following instrumentation, cormorants were released into their nocturnal roosting habitat.

Spatial data were received (and transmitted) by Service Argos, Inc. equipment aboard two National Oceanographic and

Atmospheric Administration (NOAA) polar-orbiting satellites. The data temporarily stored on satellites were sent to ground telemetry stations and were subsequently forwarded to us via electronic mail. The PTTs installed for this study were programmed to transmit for 8 hours every 48 hrs during the winter, spring, and fall, and eight hours every 10 days during the breeding season (June through August).

Using this programming, the expected longevity (battery life) of these PTTs is approximately 12 months. A Geographic Information Systems (GIS) model is being developed to illustrate cormorant locations, regional and continental movements, winter range, breeding distributions, habitat selection, migration corridors, migration corridors, and the rate and timing of migrations.

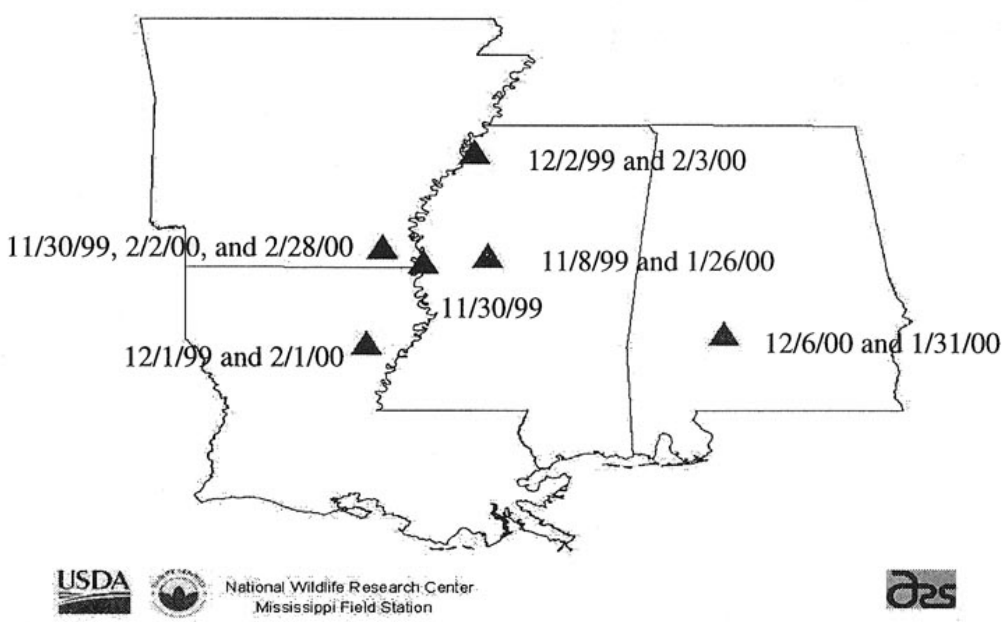

Figure 1. Capture locations for double-crested cormorants caught adjacent to aquaculture facilities in AL, AR, LA, and MS from November 1999 through March 2000. Satellite transmitters were attached to all cormorants for subsequent monitoring of regional and continental movements during a 12-month period.

Satellite telemetry at Little Galloo Island, NY

In May 2000, we initiated a similar cormorant satellite telemetry study in eastern Lake Ontario. This research was a collaborative study between the National Wildlife Research Center and the New York State Department of Environmental Conservation. The objectives of this study are to determine (1) the movements of cormorants following breeding colony control efforts (i.e., nest destruction, egg oiling), and (2) the foraging habitats used by breeding cormorants. We captured 25 double-crested cormorants by using modified leghold traps (King et al. 1998; 2000). We installed PTTs (again using a backpack harness) and released all cormorants at their breeding colony on Little Galloo Island, New York. The PTTs installed for this study were programmed to transmit for 8 hours every 48 hrs during the summer and fall, and 8 hours every 10 days during winter months.

Results

Cormorants captured near southeastern aquaculture

Based on a preliminary analysis of spatial information gathered from November 1999 through March 2000, cormorants captured adjacent to catfish farms in AL, AR, LA, and MS appeared to stay near these aquaculture facilities throughout the winter (Figure 2). Two exceptions to this fidelity were observed during these months. The individual captured in Chicot County, AR (cormorant # 05 AR) on 30 November left the predominant catfish area of southeastern Arkansas on 18 December and resided along the Arkansas River until 20 December. By December 25th, this bird migrated to southwestern Louisiana where it wintered through March 2000.

The second exception we observed in individual cormorants staying near catfish farms occurred in Alabama and Mississippi (Figure 2). On December 6th, 1999 this cormorant was fitted with a satellite transmitter in Wilcox County, AL. From 28 December through early February, this cormorant occupied the predominant catfish production areas near Greensboro and Pickensville, AL. On February 27th, cormorant # 14 AL moved northward along the Tombigbee River in eastern Mississippi. On February 28th, this bird was located via satellite telemetry at Lake Sardis in northwestern Mississippi. By March 5th, # 14 AL moved to the predominant catfish production areas in Laflore and Humphreys Counties, MS where it stayed until migrating northward to breed.

The northward migration of cormorants from their wintering areas began in April 2000. Preliminary analyses illustrated that individual cormorants can migrate > 1,700 km (1,050 mi) to their breeding colonies in the Great Lakes region of the northern United States and southern Canada. The rate of an individual's spring migration averaged 148.6 km/d (92 mi/d) as they traveled from MS to MN. Subsequent spatial analyses will illustrate the breeding distribution of cormorants captured near southeastern aquaculture facilities in winter.

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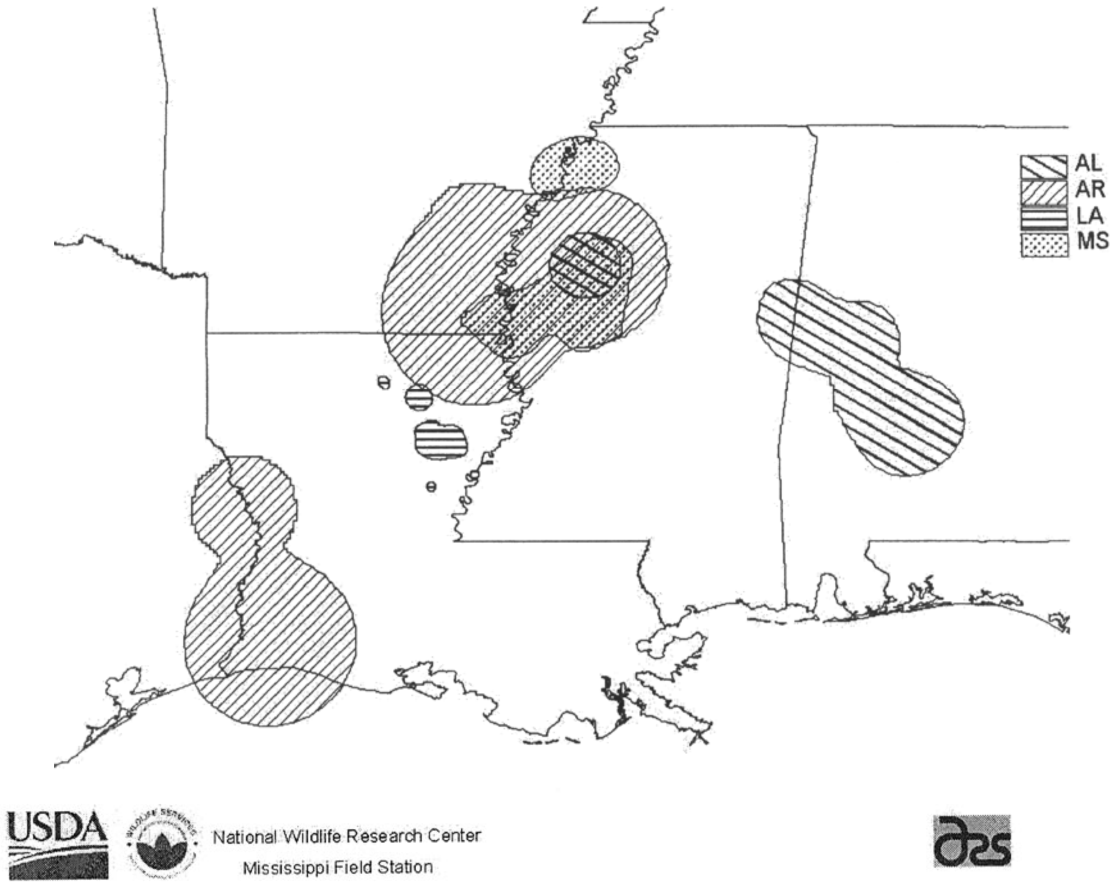

Figure 2. Satellite telemetry location data for double-crested cormorants *in*=25) captured near southeastern aquaculture facilities. Winter ranges represent cormorant movements (coded by capture state) from November 1999 through March 2000.

Cormorants captured on Little Galloo Island, NY

Based on a preliminary analysis, cormorants observed from May through September 2000 remained near the breeding colony (Figure 3). Six cormorants, however, emigrated from Little Galloo Island during the early summer. Two cormorants emigrated approximately 260 km (160 mi) from eastern Lake Ontario before July 14, and were observed near the St. Lawrence River Seaway (southwest of Montreal) through September 17. Two other cormorants left Little Galloo Island (July 4 and August 27) and flew (approximately 85 km, or 53 mi) to Oneida Lake in central New York (east of Syracuse). These birds remained near Oneida Lake through September 17. The last 2 cormorants that did not remain near Little Galloo Island during the summer of 2000 left eastern Lake Ontario (May 10 and June 1) and migrated to Oneida Lake. These individuals remained on Oneida Lake until they returned to eastern Lake Ontario on May 17 and June 13, respectively.

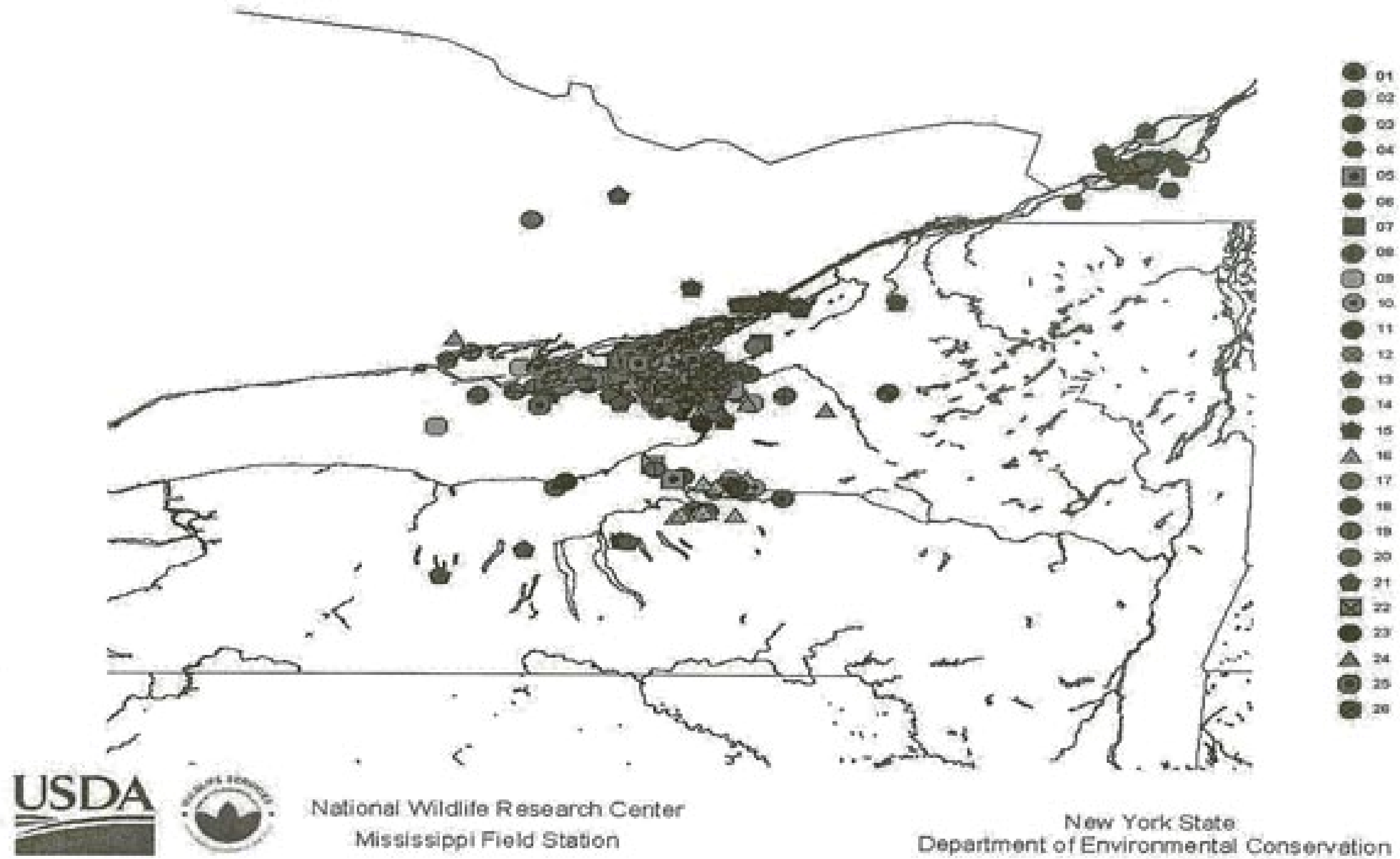

Figure 3. Satellite telemetry location data for double-crested cormorants ($n = 25$) captured on Little Galloo Island, NY (eastern Lake Ontario). Locations represent cormorant movements from May 10 through September 15, 2000.

Discussion

Satellite telemetry has been used to investigate various aspects of wildlife biology since 1970 (Table 1). The questions addressed and the sample sizes of these investigations have progressed with technology through time. Recent research has investigated the large-scale movements, behavior, and habitat relations of breeding and wintering waterbirds (Hatch et al. 2000, Petersen et al. 1999). Although previous research has revealed the ecological relationships between waterbirds and offshore fisheries (Brothers et al. 1998, Table 1), we believe the present satellite telemetry studies provide a novel investigation regarding the negative impacts of abundant wildlife populations to the production of freshwater fishes.

The preliminary insight provided herein suggests that double-crested cormorants predominantly remained near their capture locations adjacent to southeastern aquaculture facilities and in eastern Lake Ontario. Given the need for minimized impacts associated with cormorant depredation, the predicted effectiveness of management activities at breeding colonies is inversely related to the breadth of the breeding distribution of these cormorants. Site-specific control (e.g., authorized take at individual aquaculture facilities,

Table 1. Reviewed literature regarding wildlife satellite telemetry.

Questions	Wildlife species	N	Years	Investigators
body temp., den location, large-scale movements	Black bear, *Ursus americanus*	1	1969-70	Craighead et al. 1971
territory size in comparison with radio telemetry	Wolves, *Canis lupus*	23	1987-91	Ballard et al. 1998
delineation of three populations	Polar bears, *Ursus maritimus*	44	1989-91	Bethke et al. 1996
foraging distribution	Wandering Albatross, *Diomedea exulans*	30	1989-92	Weimerskirch et al. 1993
identification of four regions for conservation	White-naped Crane, *Grus vipio*	15	1991-93	Higuchi et al. 1996
foraging distribution related to fisheries	Grey seals, *Halichoerus grypus*	14	1991-93	McConnell et al. 1999
foraging distribution related to fisheries	Shy Albatross, *Diomedea cauta*	44	1993-94	Brothers et al. 1998
seabird migration patterns	Spectacled Eiders, *Somateria fischeri*	88	1993-96	Petersen et al. 1999
seabird migration patterns	Murres *(Uria aalge, U. lomvia) and* Tufted Puffins *(Fratercula cirrhata)*	53	1994-96	Hatch et al. 2000
rate and distribution of winter migration	Magellanic Penguin, *Spheniscus magellanicus*	4	1996	Stokes and Boersma 1998

colony-specific egg oiling) may continue to be ineffective if the foraging distribution of cormorants encompasses more than those areas associated with management activities.

Thus, lethal control strategies under the present cormorant depredation order may need to include take at roosting sites to supplement the temporary effectiveness of non-lethal dispersal techniques (Glahn et al. 2000b). If the ultimate results of the present studies indicate that breeding colony control efforts are effective, the distribution and abundance of breeding cormorants could be managed using colony controls (e.g., culling of breeding adults, nest destruction, egg oiling, culling of nestlings) and/or culling of adults at breeding colonies throughout the United States. Indeed, the fundamental biology of this species indicates that populations of double-crested cormorants could be most efficiently reduced by lethal take of adults (Dolbeer 1998).

When completed, the present satellite telemetry studies will facilitate the development of biologically realistic alternatives for managing double-crested cormorant impacts to commercial and recreational fisheries. The timing and location of effective cormorant management remain unknown. Based on further analyses of these spatial data, an understanding of the annual distribution of cormorants associated with commercial and recreational fishery impacts may facilitate the development of plans to minimize such impacts.

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